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SOME DISEASES OF PUERTO RICAN FORAGE CROPS

By
Thomas Theis
Plant Pathologist

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By Thomas Theis, *Plant Pathologist*

Federal Experiment Station in Puerto Rico

CONTENTS

To assist those who wish to use this publication as an aid to the identification of forage crop diseases, the host plants are listed in alphabetical order according to their scientific names. The grasses have been separated from the legumes and are listed first. The common names of the forage crops and the common names of their respective diseases are listed above. A more complete index to the grass and legume species and an index to the fungi are to be found at the end of the bulletin.

The literature has been used freely in describing disease symptoms on the host plants and in describing the morphology of the fungi causing disease. The publications of Sprague (*31*) [1] and Arthur (*4*) have been especially valuable in this respect.

Many of the fungi which cause diseases of forage crops in Puerto Rico have been described in previous reports (*32, 34, 40*). Much of this earlier work has been brought together in the Scientific Survey of Puerto Rico (*29, 30*). Although this information is valuable, it does not provide a readily available means for identification of forage crop diseases nor does it indicate their incidence or relative importance.

SURVEY OF DISEASES OF FORAGE CROPS

A survey of the diseases of forage crops in Puerto Rico was made during the period from April 1949 through September 1951. Only those grasses and legumes considered of greatest importance to Puerto Rico were included in the survey. The areas selected for study of these plants were determined in part by the report of Alberts and García-Molinari (*2*). As part of their work, they mapped those areas of the island where the important grass species are most predominant. The main objectives of the survey were to determine the most common grass and legume diseases found in Puerto Rican pastures and to evaluate their relative importance.

The forage crop diseases discussed in this bulletin are those that were found most prevalent during the survey period. Some diseases found to be of only minor importance at the time of the survey are not included in this report. The possibility always exists that these relatively minor disorders may become more serious in subsequent years.

The forage crop diseases found to be of importance in this survey are presented pictorially with accompanying descriptions of the disease symptoms, identification and description of the causal organisms, and a statement concerning the relative importance of these diseases at the time of the survey.

GRASSES

Tropical Carpet Grass

Helminthosporium leaf spot

Helminthosporium leaf spot of *Axonopus compressus* (Swartz) Beauv. (tropical carpet grass, grama colorada) is caused by an unidentified species of *Helminthosporium*. The disease has been found to some extent at all times of the year, but the greatest amount of infection occurred during the rainy seasons. During such periods, *Helminthosporium* infection caused some defoliation, although it did not appear to be of economic importance.

The spots (fig. 1, *A*) occur few to several per leaf. Most of them are elliptical, although they may coalesce and form large, irregular dis-

[1] Italic numbers in parentheses refer to Literature Cited, p. 30.

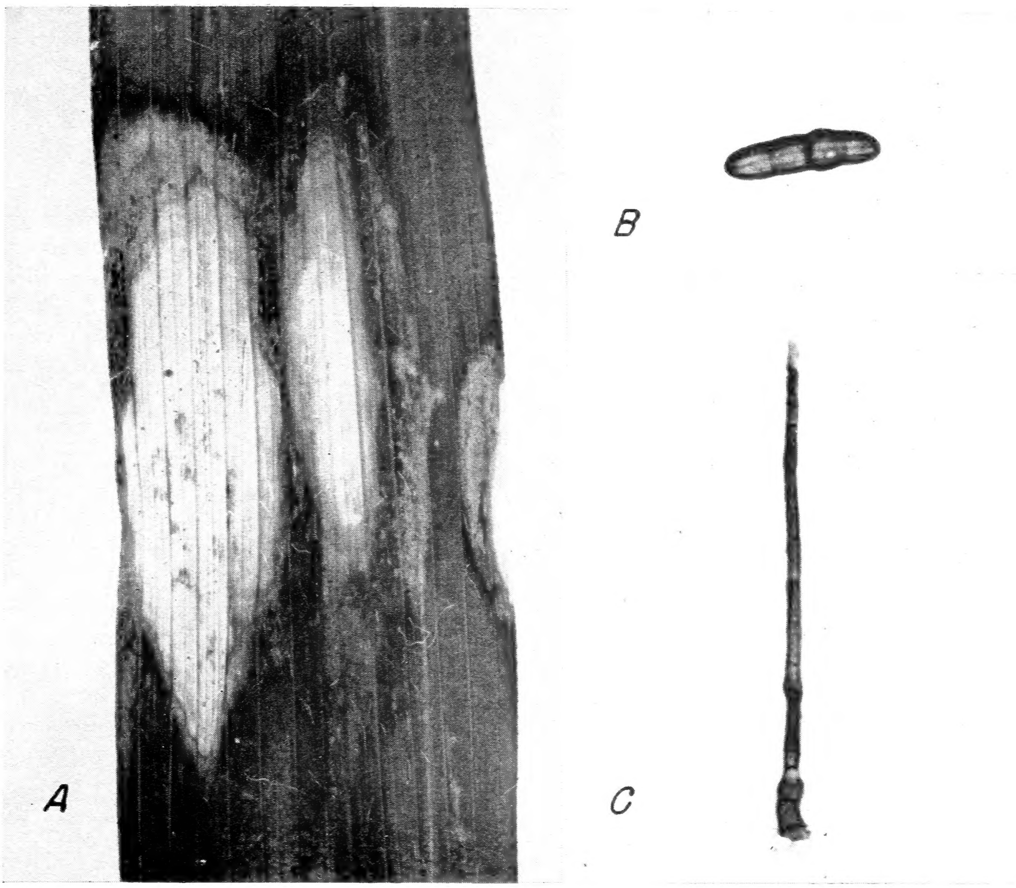

FIGURE 1.—*A*, Leaf spot on *Axonopus compressus* (tropical carpet grass) caused by an unidentified species of *Helminthosporium*. × 3.5. *B*, Spore of the fungus. × 528. *C*, Conidiophore of the fungus. × 352.

eased areas. The size of most lesions is approximately 4 mm. x 10 mm. The margin of the lesion is irregular and sunken. The spot is surrounded by a red border approximately 1 mm. wide, and the central portion becomes bleached a light tan. The spores (fig. 1, *B*) are dark brown, cylindrical, usually three-septate, and have rounded ends. They are borne on upright, unbranched, septate, dusky, conidiophores (fig. 1, *C*).

Lamilla

Helminthosporium leaf spot

Helminthosporium leaf spot of *Bouteloua heterostega* (Trin.) Griffiths (lamilla) is caused by an unidentified species of *Helminthosporium*. This disease has been endemic in Puerto Rico. Under favorable climatic conditions, it has caused extensive defoliation.

The spots (fig. 2, *A*) are few to several per leaf. They are irregular in shape and variable in size. The lesions frequently extend across the leaf blade, thus severing the upper portion. The margin of the lesion is irregular and is surrounded by a brown border of variable width. The infected area dries out and becomes a light straw color. The spores (fig. 2, *B*) are dark brown, cylindrical, usually three septate, and have rounded ends. They are borne on upright, unbranched, septate, dusky, conidiophores similar to those of the Helminthosporium spot on *Axonopus compressus* (fig. 1, *C*).

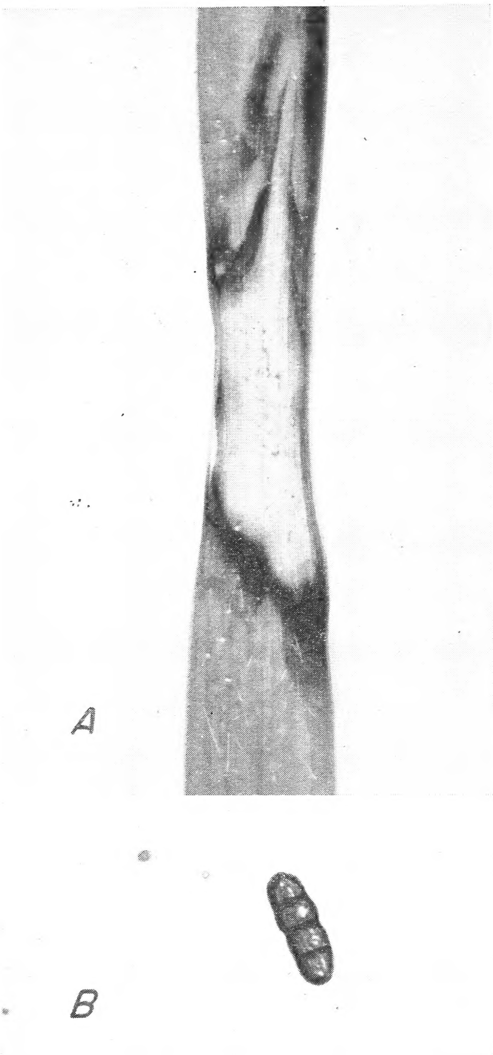

FIGURE 2.—*A*, Leaf spot on *Bouteloua heterostega* (lamilla) caused by an unidentified species of *Helminthosporium*. × 3.5. *B*, Spore of the fungus. × 528.

Paragüita

At the time of the survey, the disease incidence on *Chloris inflata* Link (paragüita) was limited. There were no diseases of outstanding prevalence.

Bermuda Grass

Rust

Rust of *Cynodon dactylon* (L.) Pers. (Bermuda grass, hala que te quedas) is caused by *Puccinia cynodontis* Lecroix. This disease has been found to some extent at all times of the year, but was most prevalent during the dry winter months. During these periods, it caused appreciable defoliation of the lower leaves.

The lesions (fig. 3, *A*) caused by this rust are cinnamon brown and are found chiefly on the underside of the leaf. The urediospores (fig. 3, *B*) are cinnamon brown, globoid, and measure 19–23μ x 20–26μ. The wall is 1.5μ to 3μ thick, very finely verrucose, and has two pores (sometimes three), located equatorially. The spores are liberated through the ruptured epidermis of the host (*4, p. 169*).

The life cycle of many of the rust fungi is complex. There is more than one spore type, and they differ in structure or may infect other hosts that are alternate in the life cycle. The uredial stage, sometimes called summer stage, which has been referred to above, is but one step in the cycle. The spores from this stage are called urediospores. Of the rust fungi included in this study, the uredial stage has been found throughout the year and is the most common spore form. All references to rust disease will be confined to the uredial stage in the present paper, since that is the one most commonly encountered.

Some difficulty may be had in determining rust infection, because all of the species of rust herein described are subject to infection by hyperparasites. That is to say, the rust which is parasitizing the plant is in turn parasitized by another fungus.

The most common hyperparasite found on rust of the Gramineae in Puerto Rico is *Darluca filum* (Biv. ex Fr.) Cast. (fig. 3, *C*). The hyphae of this fungus develop in the rust pustule, giving it a black appearance. Spore-bearing structures called pycnidia are formed. These are flask-shaped with small ostioles at the top. The spores (fig. 3, *D*) are straight, septate, broadest in the middle, and taper

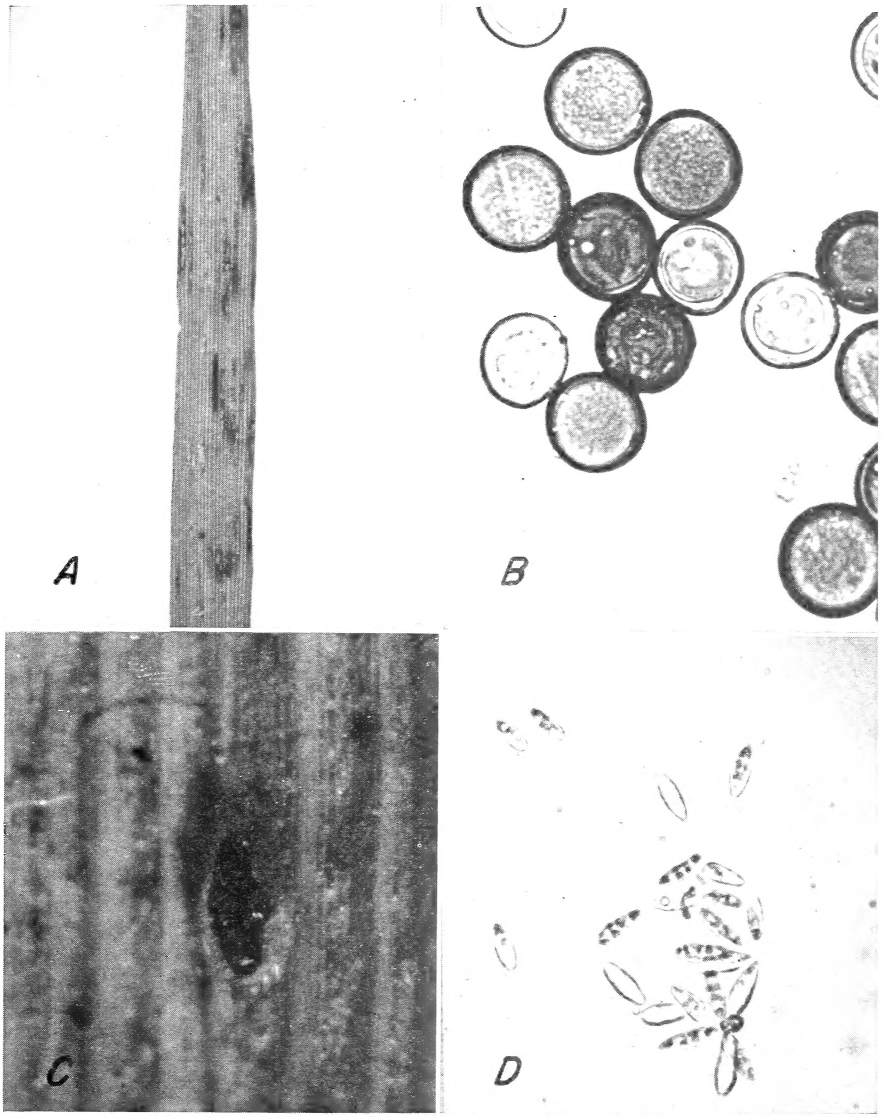

FIGURE 3.—*A*, Rust on *Cynodon dactylon* (Bermuda grass) caused by *Puccinia cynodontis*. × 3.6. *B*, Spores of *P. cynodontis*. × 528. *C*, *Darluca filum*, a fungus parasite of the rust fungi. × 8. *D*, Spores of *D. filum*. × 528.

strongly toward each end. At either end are short appendages which are easily dislodged and difficult to see. The spores are 14–18μ x 3–4μ (*31, p. 166*).

The presence of *Darluca filum* is very likely one of the factors that accounts for the seasonal cycle of rust on Gramineae in Puerto Rico. Of the grass hosts included in this study, all had their greatest rust infection during the dry, winter months. The hyperparasite, on the other hand, requires conditions of high relative humidity for its best development (*14*). Sprague (*31*) reports that rust attacks on lawn grasses in the Willamette Valley, Oregon, are checked by the parasitism of *D. filum* on the rust.

Helminthosporium leaf spot

Helminthosporium leaf spot of *Cynodon dactylon* (L.) Pers. (Bermuda grass, hala que te quedas) is caused by *Helminthosporium cynodontis* Marig. The disease was found in abundance only in areas of moderate to high rainfall (60 inches per year and above) and

then only during rainy periods. In Puerto Rico, damage from this disease was confined to patches in lawns and pastures. Damage to lawns by this fungus has been reported along the western seacoast of the United States by Sprague (*31, p. 360*) and in Kenya by Nattrass (*20*).

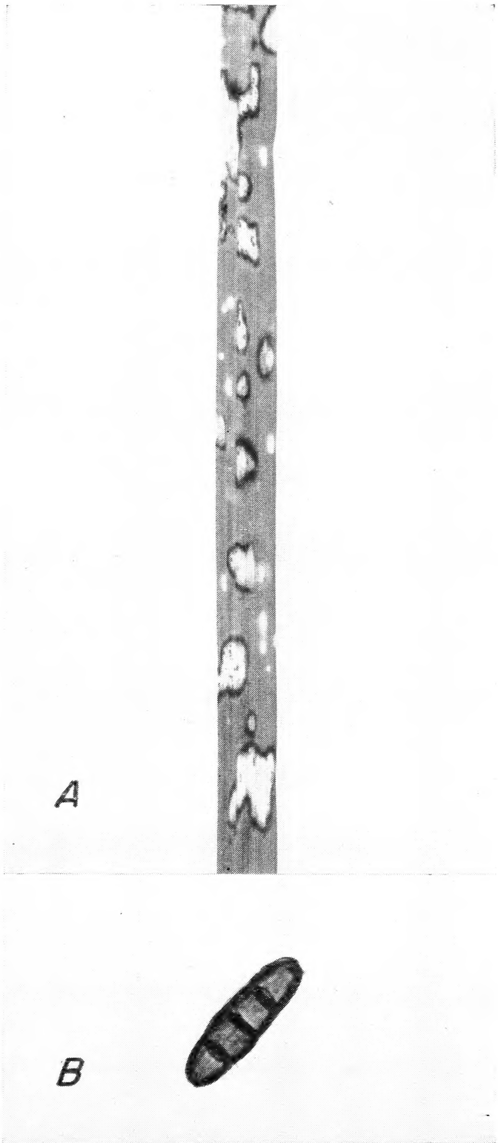

FIGURE 4.—*A*, Leaf spot on *Cynodon dactylon* (Bermuda grass) caused by *Helminthosporium cynodontis*. × 2.6. *B*, Spore of *H. cynodontis*. × 528.

The lesions (fig. 4, *A*) caused by this fungus vary in shape from small circular spots to sizeable areas of diseased tissue with irregular borders. This latter condition occurs when infection is heavy and lesions coalesce. The spots are olive-tan in the center and are surrounded by a dark-brown border. The conidiophores are septate and are dark brown. They emerge singly or in pairs. Conidiophores measure 50–150μ x 4–6μ. The spores (fig. 4, *B*) are subhyaline to fuliginous. They are never brown or dark olivaceous. The spores are three to nine septate, nonconstricted, widest near the middle, and taper slightly toward the abruptly rounded ends. They may be straight but more frequently are somewhat curved. In size they are 27–80μ x 11–14μ (*12, p. 719*).

Carib Grass

Rust

Rust of *Eriochloa polystachya* H.B.K. (Carib grass, malojilla) is caused by *Uromyces leptodermus* Syd. This disease has been found to some extent throughout the year but was most prevalent during the dry winter months. During these periods, it caused defoliation of the lower leaves but not to an extent that appeared to be of economic importance.

The lesions (fig. 5, *A*) caused by this fungus are cinnamon-brown and are found on both sides of the leaf. They are surrounded by a chlorotic area which may become necrotic. When infections are numerous, the leaves lose their dark-green color and become an overall yellowish-green. The urediospores (fig. 5, *B*) are globoid or obovoid, and are 21–26μx26–32μ. The spore wall is 1μ to 2μ thick, golden or cinnamon-brown in color, echinulate, and has three pores (sometimes four), located equatorially (*4, p. 126*). The pustules frequently are parasitized by *Darluca filum*. (See reference to parasitism of *Puccinia cynodontis* on *Cynodon dactylon* for further discussion of rust infection, p. 4).

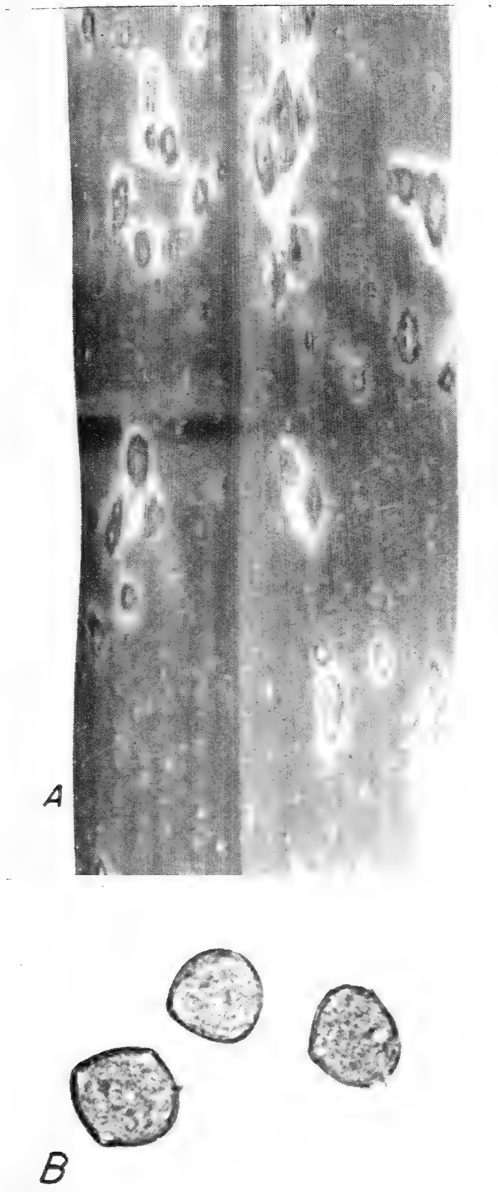

FIGURE 5.—*A*, Rust on *Eriochloa polystachya* (Carib grass) caused by *Uromyces leptodermus*. × 3.9. *B*, Spores of *U. leptodermus*. × 528.

Molasses Grass

Ergot

Ergot of *Melinis minutiflora* Beauv. (molasses grass, yaraguá) is caused by an unidentified species of *Claviceps*. Since ergot is a disease of the inflorescence it was found only during the primary flowering time in November and the secondary flowering period in April or May (*2, p. 18*). In general, the amount of infection observed was limited, and the disease appeared to be of little importance. In a few fields, however, severe infection was observed, and seed formation was negligible in these areas. Under certain environmental conditions, this disease could be a limiting factor to seed production of molasses grass in Puerto Rico.

During the sphacelial stage of this disease, spores of the fungus are exuded from the florets in droplets of a sugary matrix. This exudate causes a matted condition of infected heads (fig. 6) and makes them conspicuous in the field. The spores are hyaline, nonseptate, and are somewhat similar to those shown in

FIGURE 6.—Ergot on *Melinis minutiflora* (molasses grass) infected with an unidentified species of *Claviceps*. × 0.6.

FIGURE 7.—*A*, Ergot on *Panicum maximum* Jacq. Var. Common Guinea (guinea grass) caused by *Claviceps maximensis*. × 3.8. *B*, Spores of *C. maximensis*. × 528. *C*, Germinated sclerotium of *C. maximensis*. × 3.8. *D*, *Cerebella andropogonis* growing on the sphacelial stage of *C. maximensis*. × 3.8. *E*, Spores of *C. andropogonis*. × 528. *F*, *Cladosporium* sp. growing on the sphacelial stage of *C. maximensis*. × 3.8. *G*, Spores of the *Cladosporium* sp. × 528. *H*, Spores of *Fusarium* sp. commonly found growing on sphacelial stage of *C. maximensis*. × 528.

figure 7, *B*. The sclerotial stage, which is necessary for species identification, was not observed. (See reference to parasitism of *Claviceps maximensis* on *Panicum maximum* Var. Common Guinea for further discussion of the nature of ergot infection, p. 9.)

The exudate of the sphacelial stage is high in carbohydrate, and

other fungi grow upon it saprophytically (*19, p. 613*). In Puerto Rico, these saprophytic fungi frequently are: *Cerebella andropogonis* Ces. (fig. 7, *D, E*); *Cladosporium* sp. (fig. 7, *F, G*); *Fusarium* sp. (fig. 7, *H*); and yeasts.

Red leaf spot

The cause of red leaf spot of *Melinis minutiflora* Beauv. (molasses grass) has not been determined. Though leaf spots were abundant, especially during the vegetative period just prior to flowering, the disease did not appear to be of economic importance.

The lesions (fig. 8) are found on the leaf. They are 1–3 mm. in diameter and are irregular in shape. The dark red central portion is surrounded by a red-purple border, with indefinite margin.

On several occasions attempts were made to isolate the causal organism. Portions of young, diseased tissue were isolated aseptically and cultured at room temperature (74°–80° F.) on agar media. (Sucrose, 5 gm.; Difco yeast extract, 3 gm.; K_2HPO_4, 0.2 gm.; NaCl, 0.2 gm.; $MgSO_4$, 0.2 gm.; $CaCl_2$, 0.1 gm.; agar, 15 gm.; water, 1,000 cc.; pH 7.0.) Most of the pieces cultured had no growth of any kind. The fungi that grew were of many types and were considered as secondary organisms. In addition, infected plants were kept in a moist chamber for several days. Various fungi were observed in older lesions, but the younger, smaller spots were free of fungi or bacterial exudate.

Guinea Grass

Ergot

Ergot of *Panicum maximum* Jacq. Var. Common Guinea[2] (guinea grass, yerba de Guinea) is caused by *Claviceps maximensis* Theis. The sphacelial stage has been found throughout the year wherever guinea grass is grown in Puerto Rico. The extent of infection varied from fields with few infected heads to epiphytotics that appeared

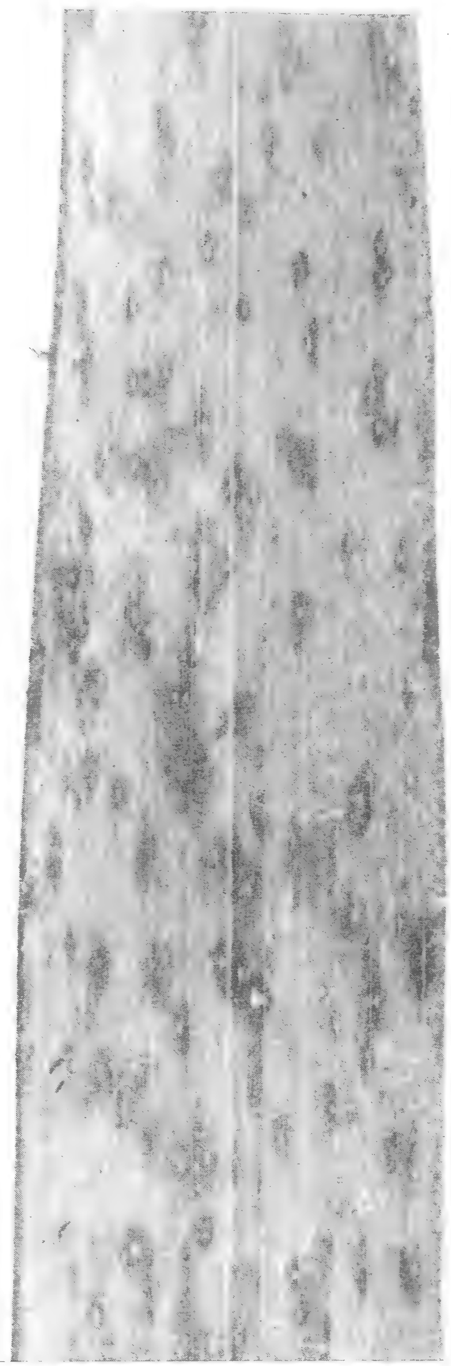

FIGURE 8.—Leaf spot on *Melinis minutiflora* (molasses grass), the cause of which has not been determined. × 3.8.

[2] Determination of varieties of *Panicum maximum* is based on a key devised by Warmke (*41, p. 143*).

to include all plants in large pastures. The sclerotial stage has been found only in the southwestern part of Puerto Rico (*39*). This otherwise dry area has a rainy period in the fall, and it is during this time that guinea grass flowers and makes its most abundant growth. Infection by *C. maximensis* has been abundant during the rainy months and sclerotia were ultimately formed. When severe infections of this disease occurred, seed production by guinea grass was negligible.

There are several stages in the life cycle of the fungus that causes ergot. The first stage is called "sphacelial," and takes place shortly after the florets have opened. It can be detected by the small droplets of sugary solution that are excreted from the florets. These droplets contain numerous, small, hyaline, nonseptate spores (fig. 7, *B*). Insects are attracted to this exudate and are often seen near infected inflorescences. By means such as insects and splashing rain, the spores are carried to other florets to continue infection.

The sphacelial stage of ergot is followed by the sclerotial stage. In the latter case, the fungus hyphae form a hard body which in some species extends out of the glumes as a hard, horny structure known as a sclerotium (fig. 7, *A*). These are resting forms that carry the fungus over adverse periods and germinate (fig. 7, *C*) when conditions are proper to form stalked stromatic heads in which the perithecia arise. These contain ascospores which are released and reinfect the host species.

Ergot infection of grasses is a potential threat to animals because of the toxic alkaloids sometimes found in the sclerotia. When the sclerotia are ingested by animals, these compounds may cause respiratory difficulties, abortion, or death. Though it is reported (*36*) that the sphacelial stage may be toxic, the sclerotial stage, with its high alkaloid content, is of most concern.

The sclerotia of *Claviceps maximensis* (fig. 7, *A*) are 2–9 mm. long x 1 mm. wide, longitudinally furrowed, and the tip usually has a cap of dried sphacelial stage hyphae. They may be straight or slightly curved. They taper upward and may be twisted. Their color is brown to gray-brown, and they are white inside. The host glumes remain attached. Chemical tests for the toxic alkaloids usually associated with the ergot sclerotia were negative. The sphacelial-stage spores (fig. 7, *B*) are hyaline, elliptical, aseptate, and are 10–30 μ x 3.5–11.0μ in size (*39*).

Identification of ergot infection on guinea grass and other host species may be complicated by the presence of other fungi growing saprophytically on the sugary exudate (*19, p. 613*). One of these that is very common on ergot infections in Puerto Rico is *Cerebella andropogonis*. This fungus grows on the exudate, and its appearance (fig. 7, *D*) has led to the misnomer, "smut." Spores of *C. andropogonis* are shown in figure 7, *E*. This fungus is of importance because it reduces the extent of sclerotia formation (*1, 26*) probably by the formation of "staling" products (*19*). Other fungi that grow on ergot exudate are *Cladosporium* sp. (fig. 7 *F, G*). *Fusarium* sp. (fig. 7, *H*), and yeasts.

Black linear leaf spot

Black linear leaf spot of *Panicum maximum* Jacq. Var. Common Guinea (guinea grass, yerba de Guinea) is caused by *Phyllosticta panici* E. Young. Though this disease has been found throughout the year to some extent wherever guinea grass is grown, it was most prevalent in the southwestern part of the island during the late fall and winter months. During these months in this area, severe epiphytotics were seen. Under such con-

FIGURE 9.—*A*, Leaf spot on *Panicum maximum* Var. Common Guinea (guinea grass) caused by *Phyllosticta panici*. × 4.0. *B*, Cross section of pycnidia of *P. panici*. × 352. *C*, Spores of *P. panici*. × 1000.

ditions, production of forage by this grass is very likely reduced markedly.

The lesions (fig. 9, *A*) are narrow, elongate, and are on the upper side of the leaf. The disease is characterized by dark-brown to black spherical pycnidia (fig. 9, *B*) that are often in clusters. They are 72–144μ in diameter. The conidia (fig. 9, *C*) are hyaline, ovate, and 4.8–9.6μ x 3.6μ in size (*44*).

Cercospora leaf spot

Cercospora leaf spot of *Panicum maximum* Jacq. Var. Common Guinea (guinea grass, yerba de Guinea) is caused by *Cercospora fusimaculans* Atk. This disease was observed on guinea grass only in

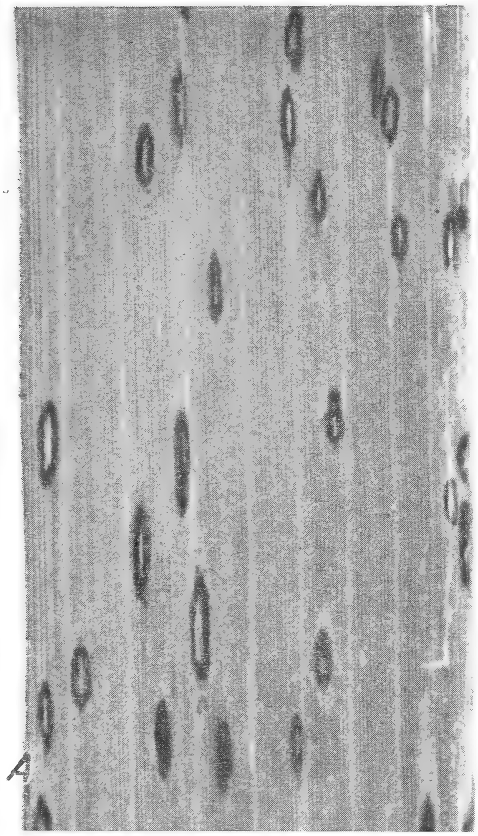

FIGURE 10.—*A*, Leaf spot on *Panicum maximum* Var. Gramalote (gramalote) caused by *Cercospora fusimaculans*. × 3.6. *B*, Spores of *C. fusimaculans*. × 528.

the southwestern part of the island. It is of no importance economically.

Of the five varieties of *Panicum maximum* in Puerto Rico (*41, p. 143*), the two most important are common guinea and gramalote. These grasses are distinguished by several features, one of the most striking being the reaction to *Cercospora fusimaculans*. Although plants of both varieties may be growing side by side, the common guinea usually is free of disease whereas the gramalote is heavily infected.

In 1949, Nolla[3] observed that guinea grass in the southwestern part of the island had a leaf spot similar to the Cercospora spot on gramalote. The causal organism was identified[4] as *C. fusimaculans*. This disease also has been observed on guinea grass in the southwestern part of the island by the author. The lesions, however, appear to be small and more sparsely scattered, as compared with the infections on gramalote. For practical purposes, this disease remains a valuable diagnostic character to differentiate common guinea grass from gramalote. (See reference to parasitism of *Cercospora fusimaculans* on *Panicum maximum* Var. Gramalote for illustrations and further discussion of this disease, p. 12.)

Gramalote

Cercospora leaf spot

Cercospora leaf spot of *Panicum maximum* Jacq. Var. Gramalote (gramalote, yerba de gramalote) is caused by *Cercospora fusimaculans*. This disease has been observed on gramalote wherever the grass is grown. It has been found to some extent at all times of the year but was most prevalent during the rainy season. At such times it may cause some defoliation.

Though the lesions of this disease on other hosts may be light brown and obscure, it causes spots on gramalote (fig. 10, *A*) that have a dark brown border and are prominent. They are usually elliptical, 3–4 mm. long, and frequently are confluent. The spots penetrate

[3] Personal communication with Dr. J. A. B. Nolla, Central Igualdad Mayagüez, P. R.

[4] By Dr. C. Chupp, Cornell University, Ithaca, N. Y.

both sides of the leaf, with the conidiophores on the upper side. They are olive-reddish-brown and are grouped in bundles. They may be straight, bent, or have knee-like swellings. The apex is slightly toothed. The conidiophores are septate, and are 50–100μ x 4.0–4.5μ in size. The conidia (fig. 10, *B*) are hyaline, three to four septate, and measure 25–40μ x 2.0μ (*31, p. 309*). (See reference to parasitism of *Cercospora fusimaculans* on *Panicum maximum* Var. Common Guinea for further discussion of this disease, p. 11).

Ergot

Ergot of *Panicum maximum* Var. Gramalote (gramalote, yerba de gramalote) is caused by the same species (*Claviceps maximensis*) that attacks common guinea (p. 9). The extent of infection and general considerations of the disease on these two hosts are much the same.

Black linear leaf spot

The black linear leaf spot disease of *Panicum maximum* Var. Gramalote (gramalote, yerba de gramalote) is caused by *Phyllosticta panici*. For illustrations and discussion of this disease, see *Panicum maximum* Var. Common Guinea infected with *Phyllosticta panici* (p. 10). The extent of infection and general considerations of the disease of these two hosts are much the same.

Pará Grass

Ergot

Ergot of *Panicum purpurascens* Raddi (Pará grass, malojillo) is caused by an unidentified species of *Claviceps*. Since ergot is a disease of the inflorescence, it was found only during flowering time which occurs from October through December (*2, p. 11*). For further discussion of this disease, see *Melinis minutiflora* infected with ergot (p. 7). The extent of infection and general considerations of the disease on these hosts are much the same.

Rust

Rust of *Panicum purpurascens* (Pará grass, malojillo) is caused by *Uromyces leptodermus*. For illustrations and discussion of this disease see *Eriochloa polystachya* infected with *U. leptodermus* (p. 6). The extent of infection and general considerations of the disease on these hosts are much the same.

Sour Paspalum

Ergot

Ergot of *Paspalum conjugatum* Bergius (sour paspalum, horquetilla) is caused by an unidentified species of *Claviceps*. This disease is found chiefly during the rainy period. For a further discussion of this disease, see *Melinis minutiflora* infected with ergot (p. 7). The extent of infection and general considerations of the disease on the hosts are much the same.

Brownseed Paspalum

Ergot

Ergot of *Paspalum plicatulum* Michx. (brownseed paspalum, gramalotillo) is caused by *Claviceps paspali* F. L. Stevens and J. G. Hall. Since this is a disease of the inflorescence it is found only during September when the plants are flowering (*2, p. 19*). The amount of infection was heavy wherever the grass was observed. Of the Paspalums in Puerto Rico, *P. plicatulum* is reported (*17, p. 29*) to be one of the most susceptible to *C. paspali*. Because of the extent of infection by *C. paspali*, seed formation is negligible. Of greater importance to Puerto Rico, is the possibility of ergot poisoning of animals feeding on infected grass. The sclerotia of *C. paspali* contain toxic alkaloids, and the poisoning of animals from this cause has been reported elsewhere (*7, 24, 25, 36*).

The sclerotia (fig. 11) of *Claviceps paspali* are yellow to gray, globose, and about 3 mm. in diameter.

They are roughened when mature. The conidia are similar in shape to those shown in figure 7, *B*. They

FIGURE 11.—Ergot on *Paspalum plicatulum* (brownseed paspalum) caused by *Claviceps paspali*. × 3.

are 5μ x 15μ in size. The oval perithecia completely cover the stromatic head. They are 340μ x 119μ in size. The asci are cylindrical and are 174μ long. The ascospores are filiform. Their measurements are 101μ x 0.5–1μ (*33*).

The exudate of the sphacelial stage is high in carbohydrate and other fungi grow upon it saprophytically (*19, p. 613*). In Puerto Rico, these are frequently: *Cerebella andropogonis* (fig. 7, *D, E*); *Cladosporium* sp. (fig. 7, *F, G*); *Fusarium* sp. (fig. 7, H), and yeasts. (See reference to parasitism of *Claviceps maximensis* on *Panicum maximum* Var. Common Guinea for further discussion of ergot infection, p. 9).

Physoderma leaf spot

Physoderma leaf spot of *Paspalum plicatulum* (brownseed paspalum, gramalotillo) is caused by *Physoderma paspali* Stevenson. This disease has been observed on gramalotillo wherever it was grown, chiefly during the rainy season. During these periods it was abundant but did not appear to have caused appreciable damage.

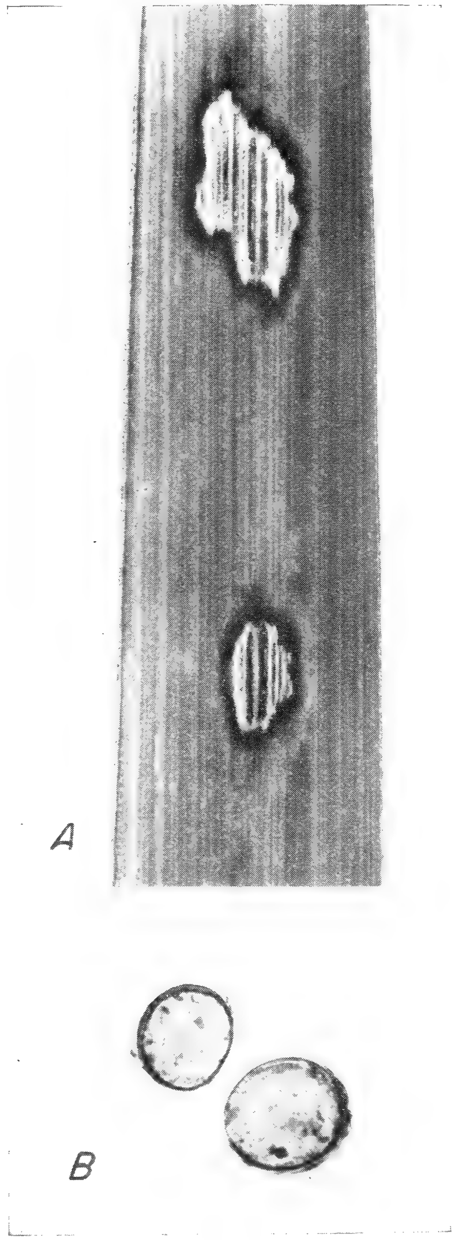

FIGURE 12.—*A*. Leaf spot on *Paspalum plicatulum* (brownseed paspalum) caused by *Physoderma paspali*. × 3.9. *B*. Spores of *P. paspali*. × 528.

The lesions (fig. 12, *A*) are found on both sides of the leaf most commonly near the juncture of the blade with the sheath. They are

chocolate-brown at first and become ashen with a diffuse gray-purplish surrounding area. The spots are oval or angular to somewhat irregular and elongated. They measure 4–8 mm. and may coalesce. The diseased areas shred with age and expose the imbedded sporangia (fig. 12, *B*). These are spherical, subspherical, or short cylindrical with rounded ends. They are golden-brown and smooth. Their measurements are 18–33μ x 15–24μ. The wall is 1μ to 1.5μ thick. (*35, p. 524*).

Rust

Rust of *Paspalum plicatulum* (brownseed paspalum, gramalotillo) is caused by *Puccinia levis* (Sacc. & Bizz.) Magn. This disease has been found to some extent at all times of the year but was most prevalent during the dry winter months. Arthur (*3, p. 230*) reports that this rust is very common in South America and extends as far north as Texas and Louisiana. The disease did not appear to cause much damage on gramalotillo in Puerto Rico.

The chestnut-brown uredia (fig. 13, *A*) are found on both sides of the leaf and are eventually surrounded by a necrotic zone. The urediospores (fig. 13, *B*) are cinnamon-brown, globoid or ellipsoid, and measure 19–29μ x 23–32μ. The wall is 1.5μ to 2.5μ thick, echinulate, with two or three pores (sometimes four), located equatorially (*4, p. 126*). The pustules frequently are parasitized by *Darluca filum*. (See reference to parasitism of *Puccinia cynodontis* on *Cynodon dactylon* for further discussion of rust infection, p. 4).

Talquezal

Tar spot

Tar spot of *Paspalum virgatum* L. (talquezal, cortadero) is caused by *Phyllachora cornispora* Atk. This disease was found all months of the year. Though at times it was so abundant as to cause some defoliation, it did not appear to be of any importance.

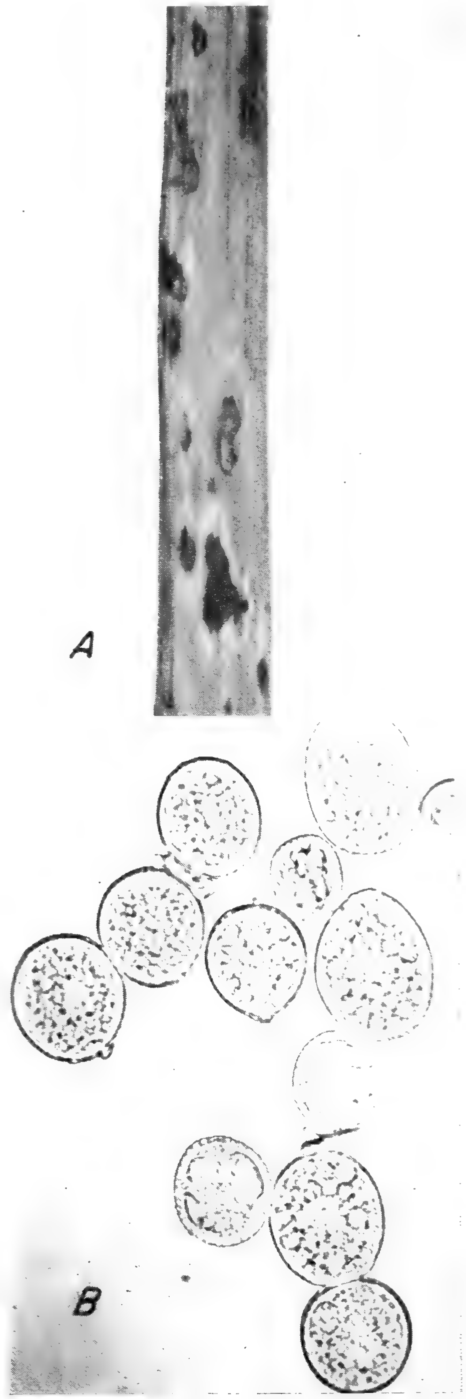

FIGURE 13.—*A*, Rust on *Paspalum plicatulum* (brownseed paspalum) caused by *Puccinia levis*. × 3.8. *B*, Spores of *P. levis*. × 528.

The black fungus stroma (fig. 14) are found on both sides of the leaf

but are more conspicuous on the upper surface. They are circular or oval to ellipsoid in form and measure 0.15–0.5 mm. wide x 0.5–

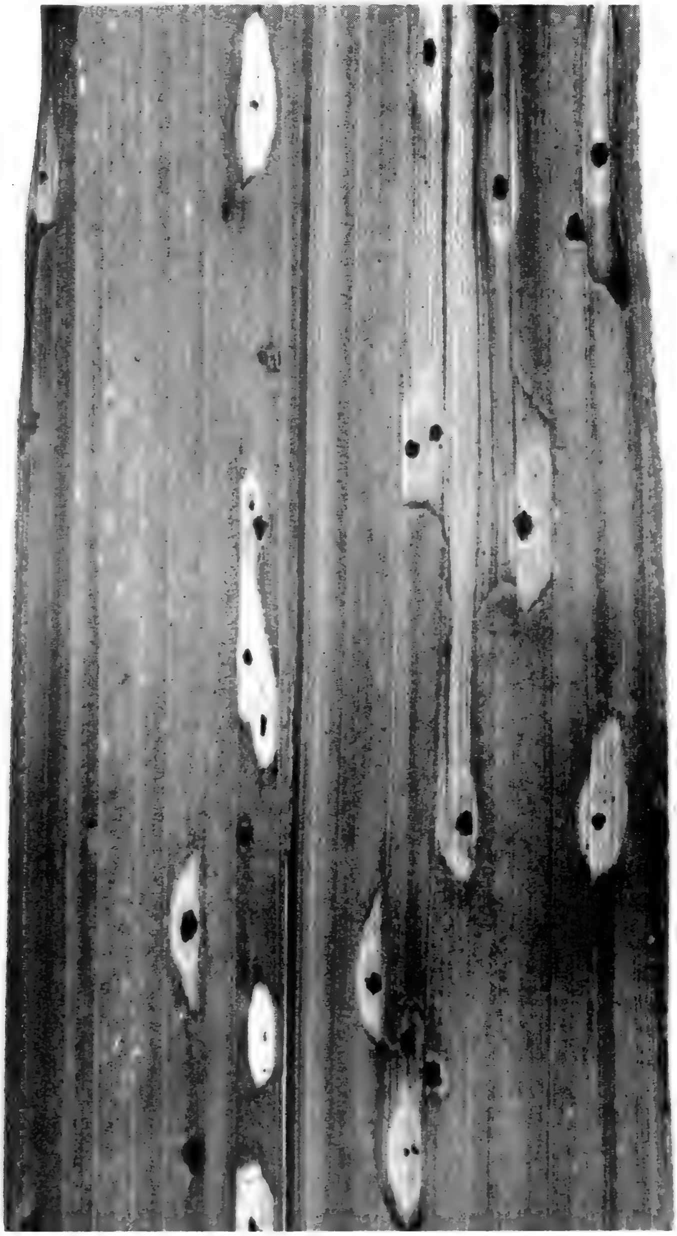

FIGURE 14.—Tar spot on *Paspalum virgatum* (talquezal) caused by *Phyllachora cornispora*. × 3.

1.5 mm. long. They are sometimes confluent and form lines up to 7 mm. long. Occasionally oval necrotic spots several millimeters long are formed. (*21, p. 35*).

Ergot

Ergot on *Paspalum virgatum* (talquezal, cortadero) is caused by an unidentified species of *Claviceps*. This disease was found chiefly during the rainy period. For further discussion of this disease, see *Melinis minutiflora* infected with ergot (p. 7). The extent of infec-

tion and general consideration of the disease on these hosts are much the same.

Buffel Grass

At the time of the survey, the disease incidence on *Pennisetum ciliare* (L.) Link (buffel grass, yerba de Salinas) was limited. There were no diseases of outstanding prevalence.

Napier Grass

Gray spot

Gray spot of *Pennisetum purpureum* Schumach. (napier grass, yerba elefante) is caused by *Piricularia grisea* (Cke.) Sacc. This disease has been observed at all times of the year on both napier and on Merker grass (*Pennisetum purpureum* var. *merkeri*) (*43*). It was found, however, only on the first, small leaves that appeared after cutting. The number of lesions observed has been large in some fields, but the disease appeared to do little harm.

FIGURE 15.—Gray spot on *Pennisetum purpureum* (napier grass) caused by *Piricularia grisea*. × 3.6.

The elliptical spots (fig. 15) may be confluent and are approximately 2 mm. wide x 6 mm. long. The central portion of the lesion is an ashy gray, and it is bordered by an indefinite purple-red zone. The conidiophores are gray or tinted, septate, and have a basal cell that is somewhat swollen. They are simple, or sparingly branched, somewhat bent, and penetrate through the stomata in clusters of two to five. The measurements of the conidiophores are 60–120μ x 405μ. The conidia are single, somewhat dark colored, and are borne terminally in scorpioid cymes. They are ovate, two-septate, and the apical cell is cone-shaped or slightly beaked. The conidia are broadest at the lower septum, and the base has a slight hilum-like terminal where it breaks from the stalk. Their measurements are 18–22μ x 9–11μ (*31, p. 415*).

Eyespot

Eyespot of *Pennisetum purpureum* (napier grass, yerba elefante) is caused by *Helminthosporium sacchari* (Breda de Haan) Butl. (*22, p. 46*). In the scattered small plantings of napier that were observed in Puerto Rico, this disease was found but not to such an extent that the plants were harmed. This leaf disease, which also attacks sugarcane (*23, p. 90*) may cause serious losses. Plantings of napier grass in Puerto Rico, especially along the north coast were at one time so severely attacked that they were replaced with Merker grass (*Pennisetum purpureum* var. *merkeri*) which is re-

sistant to the disease (*9, 28*). In Florida, napier plots were killed by eyespot (*27*). An epidemic of the disease in Hawaii in 1939 practically eliminated napier grass as a forage crop (*38*).

The following are symptoms of this disease on the different parts of the plant:

Leaf.—The spots (fig. 16, *A*) appear first as small, red-brown, oval flecks. As they enlarge the center becomes lighter brown and the margins red. Finally, the centers become a dirty straw color and the margins a Bordeaux red. Their measurements are 1.5 to 3 mm. wide and 2 to 5 mm. long. Some strains of napier may develop long streaks in the leaf. Spots on the leaf sheath are larger, lighter in color, and more diffuse in outline.

Leaf spots somewhat similar in size and color to the eyespot lesions may be caused by potash deficiency (*8*). The irregular, or indefinite outline of these lesions differs from the elliptical, sharply defined borders of the infections caused by the eyespot fungus. No fungi were isolated from young lesions surrounded by green healthy tissue.

Stem.—Stem lesions are more elongate than leaf lesions and are correspondingly narrower. They are smooth at first, regular in outline, and reddish-brown, with or without a lighter colored center. Later they become sunken, irregular in shape, and bluish-purple to black. The border may be grayish-white or retain the original reddish-brown color. Most lesions are found on the first 6 inches above the ground and are more commonly at the nodes. Affected stems are shrunken, pithy, and partly or completely hollow; when split longitudinally in the region of the cankers, the interior of the stem is seen to be diseased or dead in part or in whole.

Crown.—The crown is seldom affected; occasionally, however, diseased tissue can be found and the basal buds are withered and darkened, and their subsequent growth is stunted.

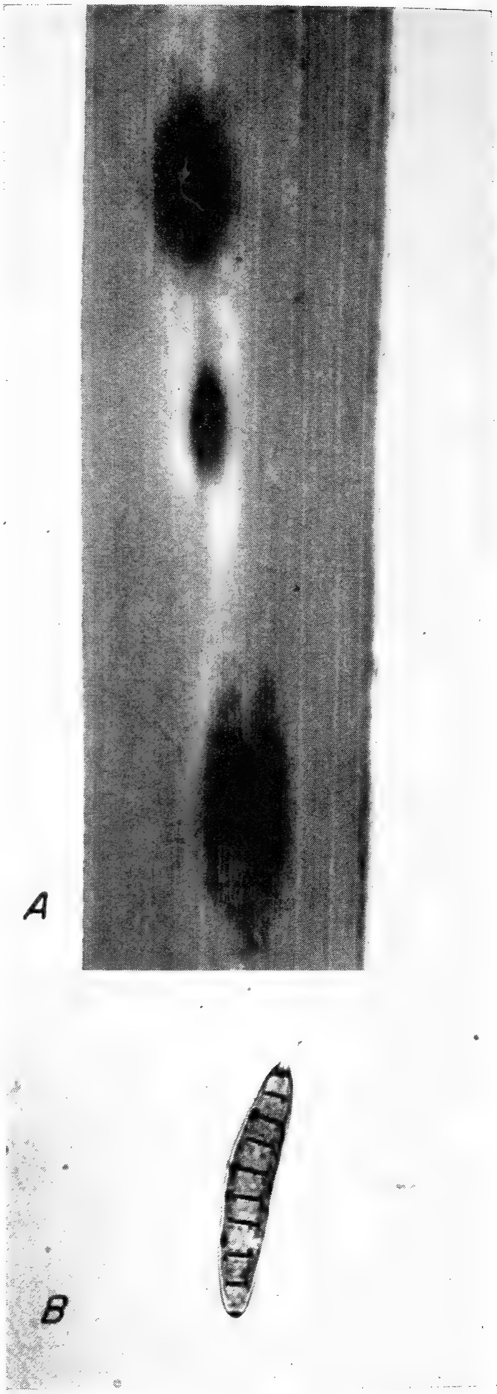

Figure 16.—*A*, Eyespot on *Pennisetum purpureum* (napier grass) caused by *Helminthosporium sacchari*. × 3.6. *B*, Spores of *H. sacchari*. × 528.

Roots.—The roots are not thought to be attacked, but affected plants have weakened root systems

and are knocked over and trampled by grazing animals.

From a distance, badly diseased napier plots appear to be blasted by lightning or burned by fire. Plantings that have been diseased for some time show an abundance of partly developed adventitious side shoots in various stages of destruction by the disease.

The spores (fig. 16, *B*) of *H. sacchari* are produced on nonbranched conidiophores that are many septate, and have angular inequalities or geniculations marking the insertion of an originally apical spore. The spores are straight, moderately or markedly curved, long-elliptical, with the greatest diameter near the middle or at one end and gradually taper to rounded or slightly pointed ends. They are many septate and vary from light to dark brown. The spore size is variable and depends in part on the temperature at which it develops (*22, p. 52*).

Resistant varieties of napier grass are available for control of this disease. Merker grass is resistant to eye-spot and resistant crosses of Merker and napier have been developed (*38*). Resistant varieties of napier have been developed at the Georgia Coastal Plain Experiment Station (*8*).

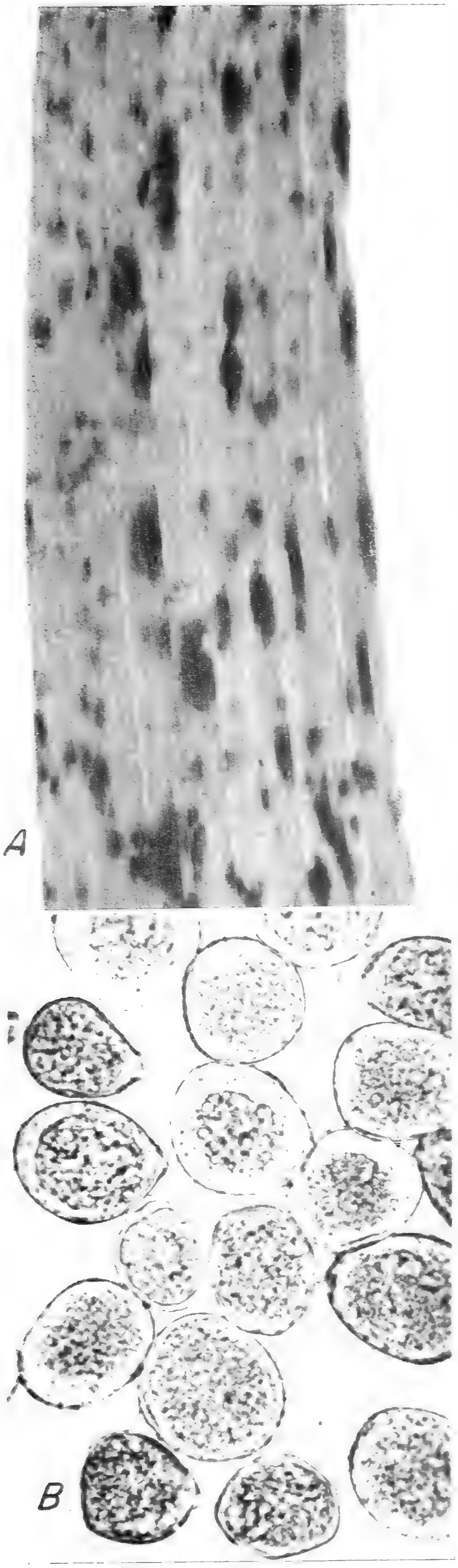

FIGURE 17.—*A*, Rust on *Sorghum vulgare* (sorghum) caused by *Puccinia purpurea*. × 3.8. *B*, Spores of *P. purpurea*. × 528.

Sorghum

Rust

Rust on *Sorghum vulgare* Pers. (sorghum, millo) is caused by *Puccinia purpurea* Cke. This disease has been found at all times of the year, but it was most prevalent during the dry, winter months. When infection is abundant, production of forage by millo is very likely reduced because of defoliation of the lower leaves.

The chestnut-brown uredia (fig. 17, *A*) are found on both sides of the leaf and are surrounded by a reddish-purple elliptic zone. When infections are numerous these areas

become confluent and give the leaf an overall red cast. There are prominent peripheral, clavate, or capitate paraphyses. The urediospores (fig. 17, *B*) are ellipsoid or oblong and measure 23–31μ x 29–40μ. The spore wall is verrucose-echinulate, cinnamon or dark chestnut-brown in color, and 1.5μ to 2μ thick. There are 5–10 pores that are scattered or in zones (*4, p. 124*). The pustules are frequently parasitized by *Darluca filum*. (See reference to parasitism of *Puccinia cynodontis* on *Cynodon dactylon* for further discussion of rust infection, p. 4).

Smut

Loose kernel smut of *Sorghum vulgare* (sorghum, millo) (fig. 18, *A*) is caused by *Sphacelotheca cruenta* (Kuehn) Potter. It has been found scattered throughout sorghum plantings. Both grain and forage yields may be reduced when fields are heavily infected.

One of the symptoms is a dwarfed condition of the plant. Such plants are less than half as tall as uninfected plants, and they head out early. When infected plants flower, usually all of the flowers in the head are smutted (fig. 18, *B*). The seed is replaced by a dark mass of spores enclosed in a membrane. This covering is fragile and ruptures early. An elongate fungus structure known as a columella persists. Frequently the lemma and palea as well as the ovary contain smut sori. The floral bracts tend to elongate and proliferate.

The sori are formed in the ovaries and floral bracts. The chlamydospores are enclosed in a fungal membrane composed of loosely joined, rounded-gray cells about twice the diameter of the spores. The chlamydospores are formed in elongated, irregular clumps, not spore balls, that separate as they mature. The spores (fig. 18, *C*) are round to elliptical, dark brown, and have indistinct pits or reticulations on the surface. They are 5μ to 10μ in diameter (*11, p. 175*).

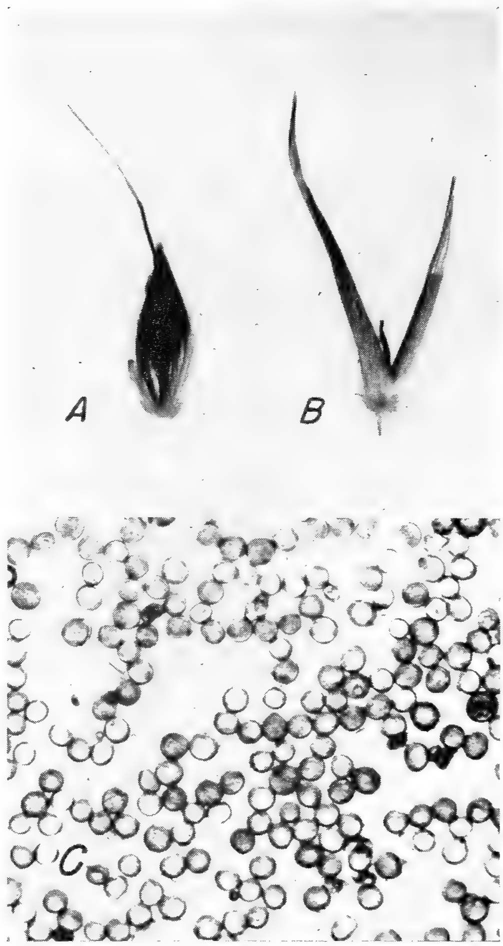

FIGURE 18.—*A*, Noninfected seed of *Sorghum vulgare*. × 3. *B*, Loose kernel smut on *S. vulgare* caused by *Sphacelotheca cruenta*. × 3. *C*, Spores of *S. cruenta*. × 528.

Cercospora leaf spot

Cercospora leaf spot of *Sorghum vulgare* (sorghum, millo) is caused by *Cercospora sorghi* Ell. & Ev. This disease was most prevalent on millo during the rainy periods. During these periods it caused extensive leaf spotting but no appreciable damage.

Infected leaves (fig. 19, *A*) have dark purple elongate spots that may be several inches long. The colored part becomes dead and dry. The conidiophores are found on both sides of the leaf in minute,

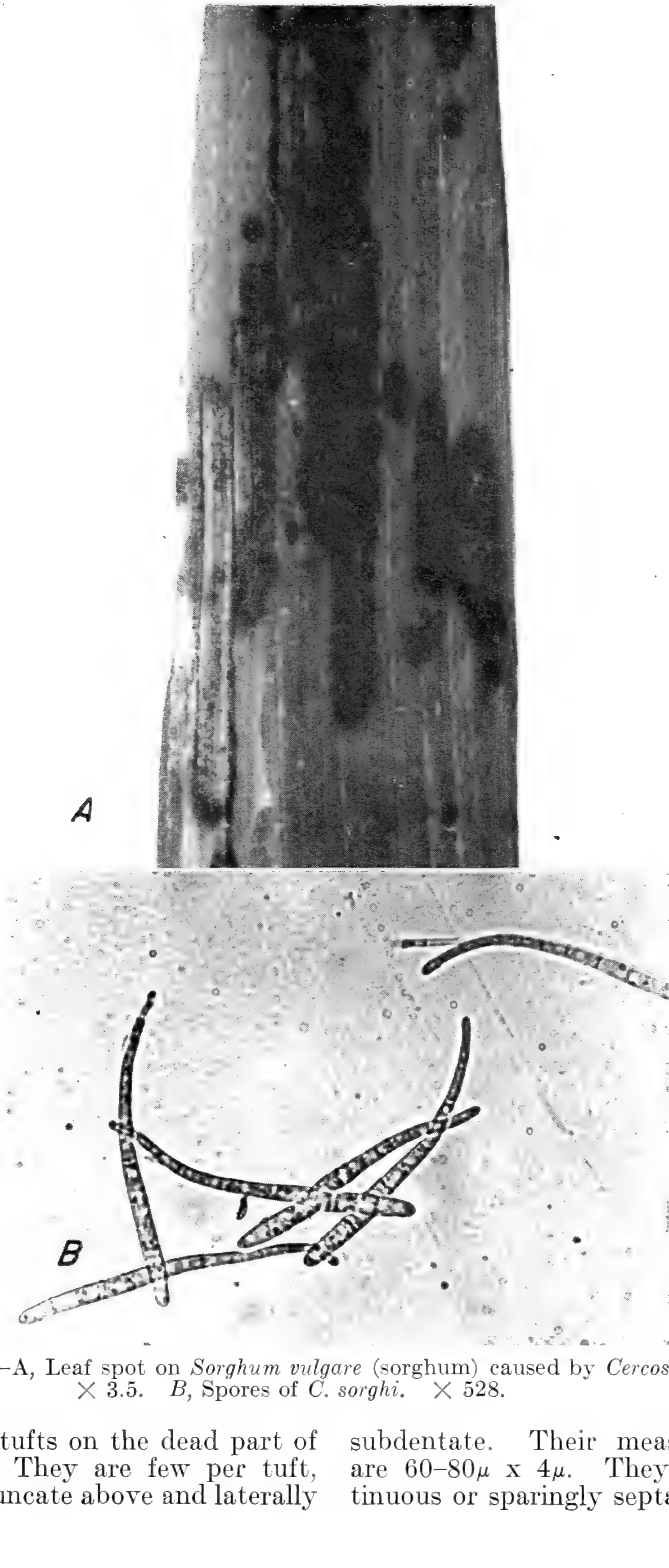

Figure 19.—A, Leaf spot on *Sorghum vulgare* (sorghum) caused by *Cercospora sorghi.* × 3.5. *B,* Spores of *C. sorghi.* × 528.

scattered tufts on the dead part of the leaf. They are few per tuft, brown, truncate above and laterally subdentate. Their measurements are 60–80μ x 4μ. They are continuous or sparingly septate below.

The conidia (fig. 19, *B*) are slender, faintly three-or-more-septate, and hyaline. Their measurements are 70–80μ x 3μ. The tufts of conidiophores are so minute as to be barely visible with a lens (*13, p. 15*).

West Indies Smutgrass

Sooty spike

Sooty spike on *Sporobolus indicus* (L.) R. Br. (West Indies smutgrass, cerrillo) is caused by *Helminthosporium ravenelii* Curt. This is a disease of the inflorescence and can be found in all seasons since cerrillo blossoms at all times of the year (*2, p. 12*). This disease was observed in Puerto Rico wherever the grass was growing. Drechsler (*12, p. 689*) suggests that the distribution of the disease is practically coterminous with *S. indicus*. When infection was severe, it was difficult to find specimens entirely free of disease.

The extensive infection of *Sporobolus indicus* by *Helminthosporium ravenelii* has been recorded elsewhere (*10, p. 352; 18, p. 26*). The disease is so much a part of the grass that such misnomers as "black seed grass" (*10*) and "smut grass" (*16*) have been assigned to it. The disease is of no importance economically, although Ratera (*25*) reports that *Sporobolus berteroanus* Hitchc. & Chase (*Sporobolus poiretii* (Roem. & Schult.) Hitchc.) is toxic to animals when parasitized by Helminthosporium.

The infected inflorescences (fig. 20, *A*) are most noticeable in the latter stages of infection, when the disease is black and crusty. A noninfected inflorescence is shown in figure 20, *B*. During the early stages, the disease is present as a brownish-olive velvety or spongy layer that later becomes increasingly dark. The velvety layer is composed of crowded sporophores that arise from a mat of hyphae that occupy the superficial layers of the affected floral parts. The sporophores are septate, have a tendency to branch, and are light fuliginous to light yellow. They are very torulose and hence decidedly variable in diameter (5–10μ). The length often exceeds 500μ. The spores (fig. 20, *C*) are straight or

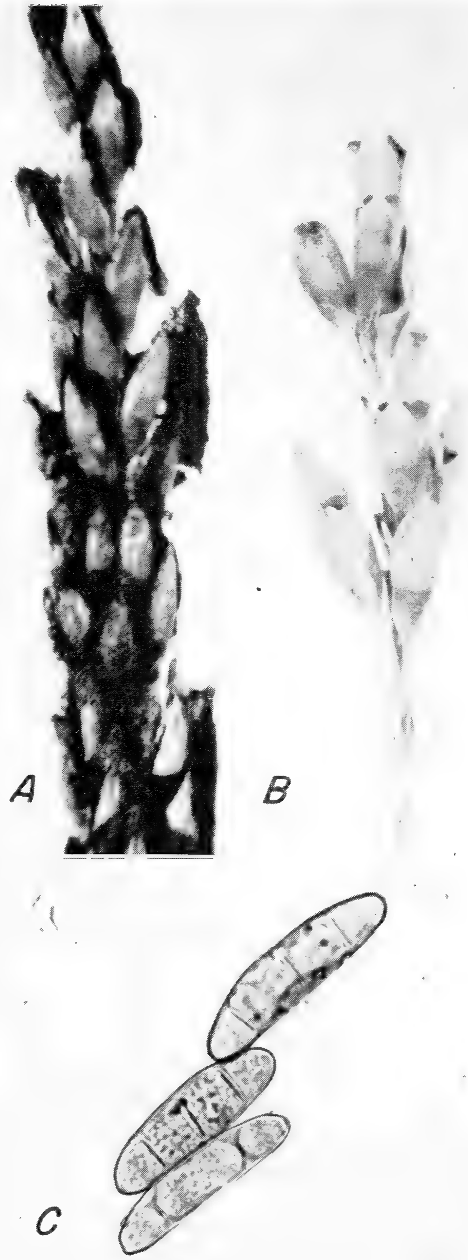

FIGURE 20.—*A*, Sooty spike on *Sporobolus indicus* (West Indies smutgrass) caused by *Helminthosporium ravenelii*. × 8. *B*, Florets free of disease. × 8. *C*, Spores of *H. ravenelii*. × 528.

show a slight crescentic or sigmoid curve and are rounded at both ends. They are one to five (usually three or four) septate. The septa are rarely associated with constrictions in the thin cell wall. The small dark hilum is readily observed (*12, p. 689*).

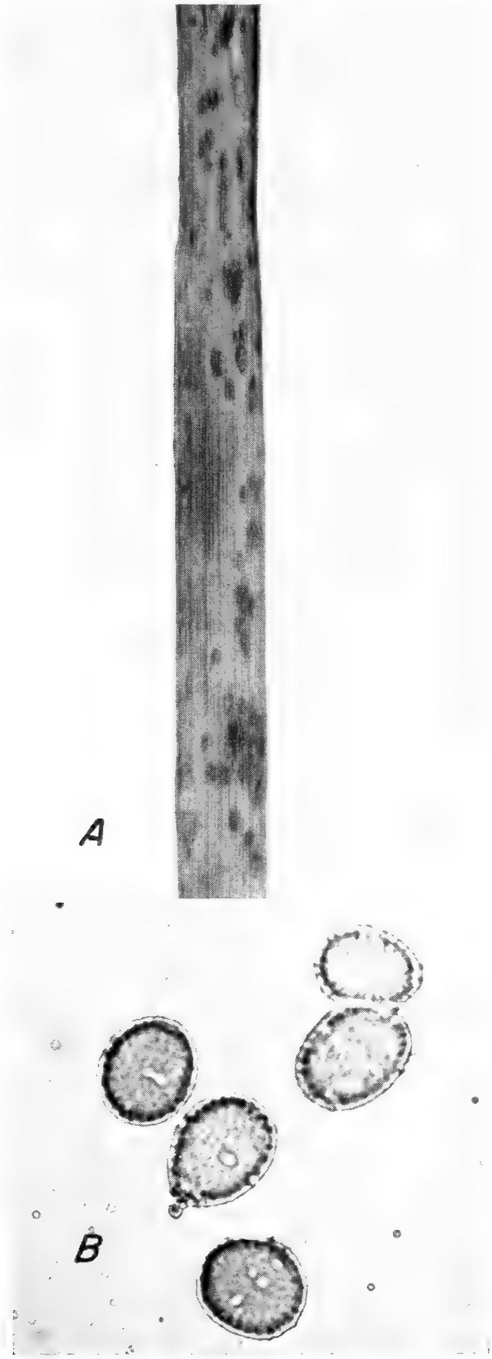

FIGURE 21.—*A*, Rust on *Sporobolus indicus* (West Indies smutgrass) caused by *Uromyces ignobilis.* × 3.7. *B*, Spores of *U. ignobilis.* × 528.

Rust

Rust of *Sporobolus indicus* (West Indies smutgrass, cerrillo) is caused by *Uromyces ignobilis* (Syd.) Arth. This disease has been found at all times of the year but is most prevalent during the dry winter months. During such periods it caused defoliation of the lower leaves but not to a degree of economic importance.

The lesions (fig. 21, *A*) caused by this fungus are cinnamon-brown and are found on both sides of the leaf. The urediospores (fig. 21, *B*) are broadly ellipsoid and have a strongly echinulate, bright cinnamon-brown wall that is 2μ to 2.5μ thick. There are four pores located equatorially. The spore measurements are 19–23μ x 21–26μ (*4, p. 137*). The pustules are frequently parasitized by *Darluca filum.* (See reference of parasitism of *Puccinia cynodontis* on *Cynodon dactylon* for further discussion of rust infection, p. 4).

Seashore Dropseed

At the time of the survey, the disease incidence on *Sporobolus virginicus* (L.) Kunth (seashore dropseed, matojo de burro) was limited. There were no diseases of outstanding prevalence.

St. Augustine Grass

Smut

Smut of *Stenotaphrum secundatum* (Walt.) Kuntze (St. Augustine grass, cinta) is caused by *Ustilago affinis* Ell. & Ev. In regions of high rainfall (100 inches and above), St. Augustine grass was found heavily infected. It was not found in the "haystack" hill region on the north side of the island, where the species is one of the most important pasture grasses (*2, p. 13*). This disease, one of the commonest smuts in Puerto Rico (*42, p. 114*) does not

appear to be of importance on St. Augustine grass.

Ustilago affinis infects the floral parts (fig. 22, *A*) of St. Augustine grass. The sori in the inflorescence are 4–10 mm. long, dark brown, very dusty, and soon expose the naked rachis. There is at first however, a covering by a thin, very fragile, grayish membrane. The spores (fig. 22, *B*) are a clear yellowish-brown. They are globose, irregularly globose to ovoid, or somewhat angular. Their measurements are 4–5μ x 7–8μ. The epispore is very thin and smooth (*15, p. 318*).

Guatemala Grass

Rust

Rust of *Tripsacum laxum* Nash (Guatemala grass, yerba de Guatemala) is caused by *Puccinia polysora* Underw. This disease has been observed to some extent at all times of the year, but it was most prevalent during the dry winter months. During these periods heavy infestations occurred that caused sufficient defoliation to reduce yields.

The lesions (fig. 23, *A*) caused by this fungus are found on both sides of the leaf. The pustules are oblong and usually are dehiscent by a longitudinal slit. When infections are abundant the spots become confluent and the chlorotic zones (ultimately necrotic) give an overall yellow and, finally, a brown cast to the leaf. The cinnamon-brown urediospores (fig. 23, *B*) are globoid or ellipsoid. The wall is 1.5μ to 2μ thick, finely and sparsely echinulate, and has five (rarely four) equatorial pores. The spore measurements are 24–29μ x 27–34μ (*4, p. 117*). The pustules are frequently parasitized by *Darluca filum*. (See reference of parasitism of *Puccinia cynodontis* on *Cynodon dactylon* for further discussion of rust infection, p. 4).

FIGURE 22.—*A*, Smut on *Stenotaphrum secundatum* (St. Augustine grass) caused by *Ustilago affinis*. × 3.7. *B*, Spores of *U. affinis*. × 528.

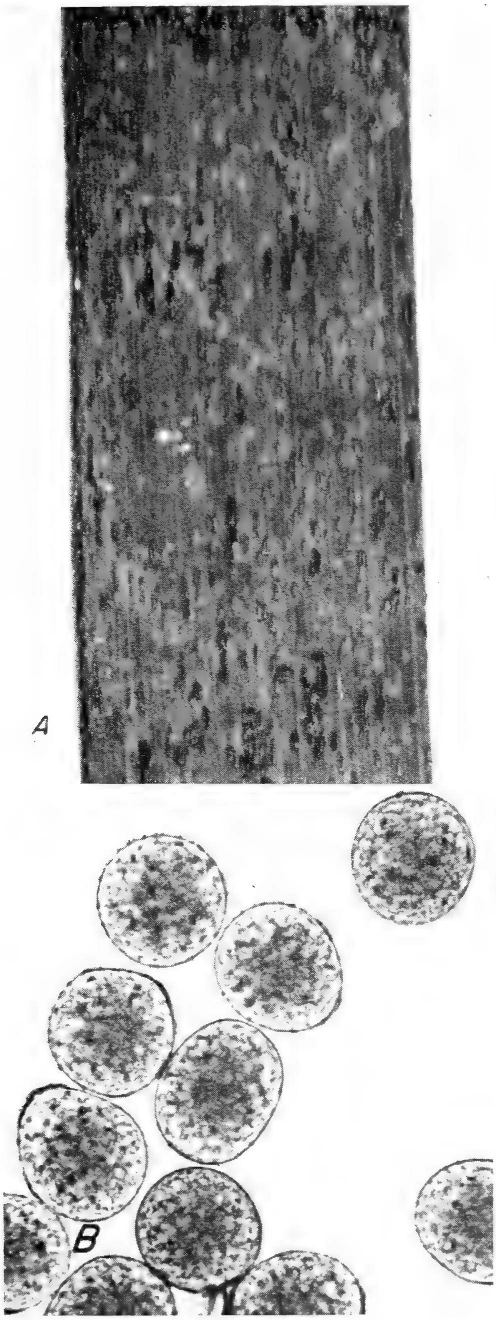

FIGURE 23.—*A*, Rust on *Tripsacum laxum* (Guatemala grass) caused by *Puccinia polysora*. Reduced 2.3 percent. *B*, Spores of *P. polysora*. × 528.

LEGUMES

Tropical Kudzu

Powdery mildew

Powdery mildew of *Pueraria phaseoloides* (Roxb.) Benth. (tropical kudzu) is caused by a species of *Oidium*. It occurred to some extent throughout the year but was most prevalent during the dry winter months. During these periods severe infection has been observed. Defoliation of infected leaves was sufficient to reduce the amount of forage produced.

A number of powdery mildew fungi thrive best in dry weather. This is due in part to the ability of their short-lived spores to develop in air that is devoid or very low in moisture (*5*, *6*). In addition, the dryness of the atmosphere retards the growth of other fungi parasitic on the mildews (*5*).

Powdery mildew infects the leaves (fig. 24, *A*). It appears first as white spots on the surface of the leaves; ultimately these coalesce and involve the entire leaf surface. The leaf becomes puckered, then brown and dry, and finally drops. The spores (fig. 24, *B*) are hyaline and measure 14–24μ x 31–40μ.

Complete identification of the causal organism has not been possible because the perithecial stage, necessary for identification of the fungus, has not been found. Stevens (*32*), though he observed the conidial stage of powdery mildew on many hosts in Puerto Rico, was not able to find the perithecial stage. According to Bessey (*5*) perithecial production by powdery mildew is rare in the Tropics.

Velvetbean

Stem spot

A stem spot on *Stizolobium deeringianum* (Bort.) (velvetbean, habichuela terciopelo) has been observed, the cause of which has not been determined. This disease occurred only on heavy clay soils during periods of high rainfall. During such periods, it became so severe that large patches in velvetbean plantings were killed.

The stems and petioles develop black, sunken spots (fig. 25), the size of which are 1–3 mm. x 4–7

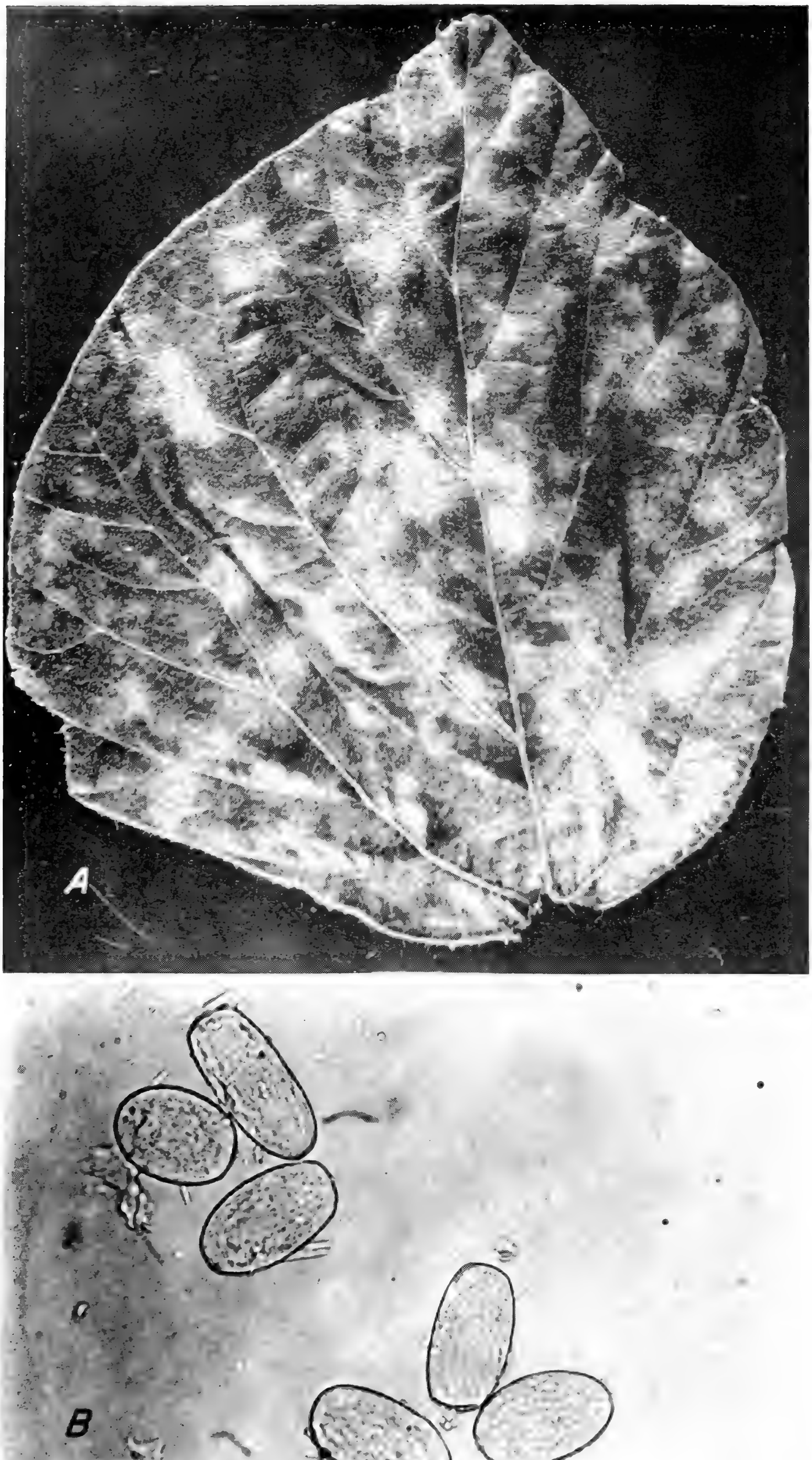

FIGURE 24.—*A*, Powdery mildew on *Pueraria phaseoloides* (tropical kudzu) caused by an unidentified species of *Oidium*. × 1.4. *B*, Spores of *Oidium* sp. × 528.

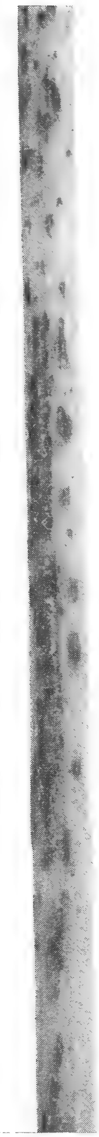

FIGURE 25.—A stem spot on *Stizolobium deeringianum* (velvetbean), the cause of which has not been determined. × 2.2.

mm. Coalesced spots are much larger.

On several occasions attempts were made to isolate the causal organism. Portions of young diseased tissue were isolated aseptically and cultured at room temperature (74°–80° F.) on agar media (sucrose, 5 gm.; Difco yeast extract, 3 gm.; K_2HPO_4, 0.2 gm.; NaCl, 0.2 gm.; $MgSO_4$, 0.2 gm.; $CaCl_2$, 0.1 gm.; agar, 15 gm.; water, 1,000 cc.; pH 7.0). Most of the pieces cultured had no growth of any kind. The fungi that grew were of variable types and were considered as secondary organisms. In addition, infected plants were kept in a moist chamber for several days. Various fungi were observed in older

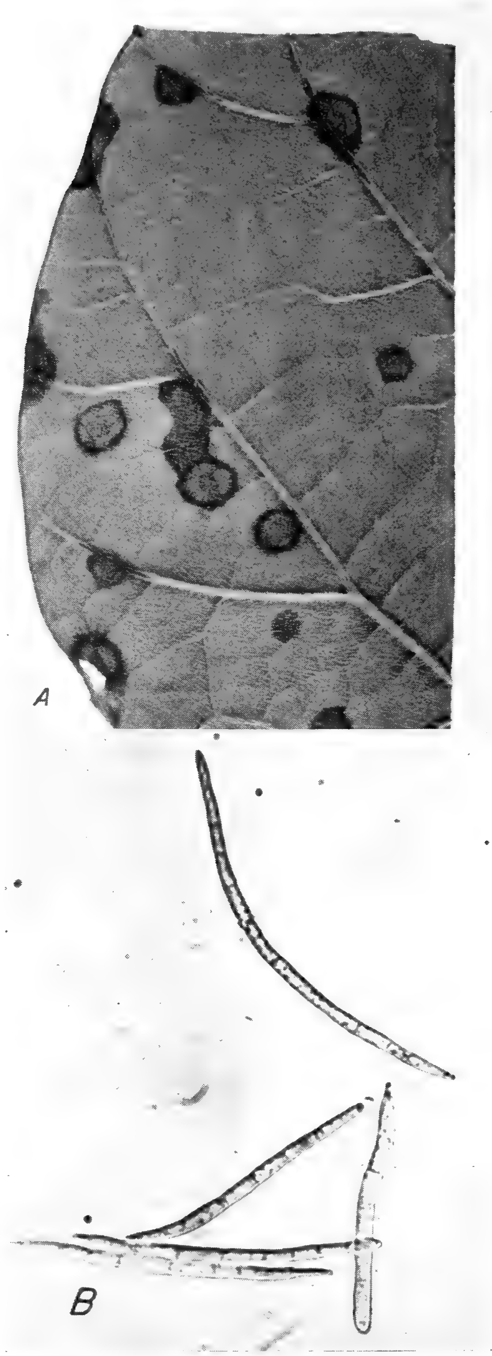

FIGURE 26.—*A*, Leaf spot on *Stizolobium deeringianum* (velvetbean) caused by *Cercospora stizolobii.* × 3.6. *B*, Spores of *C. stizolobii.* × 528.

lesions, but the younger, smaller spots were free of fungi or bacterial exudate.

Cercospora leaf spot

Cercospora leaf spot on *Stizolobium deeringianum* (velvetbean) is caused by *Cercospora stizolobii* Syd. This disease was found at all times of the year. It appeared to be restricted to the older leaves. Since these are usually covered by new growth, the disease is not too noticeable. The older leaves, however, are often heavily infected, although the disease does not seem to be of economic importance.

The leaf spots (fig. 26, *A*) are 2–4 mm. in diameter and are found on both sides of the leaf. They are ochraceous brown with raised, dark-brown margins. The tufts of hyphae are found on both sides of the leaf but are usually on the lower surface. They are 50–70μ in diameter, dark olivaceous, inconspicuous, and are located at the center of the spots. The conidiophores are olivaceous, fasciculate, straight, simple, rarely septate. Their measurements are 20–38μ long x 3.5–4.0μ wide. The conidia (fig. 26, *B*) are cylindrical to subclavate, obtuse at both ends or narrowed at one end. They are three to seven septate, not constricted at the septa, or only slightly so. Their color is pale olivaceous. Their measurements are 35–60μ long x 3.5–5μ wide (*37, p. 270*).

INDEX TO GRASS AND LEGUME SPECIES

INDEX TO THE FUNGI

Literature Cited

(1) Ajrekar, S. L.
1926. OBSERVATIONS ON A DISEASE OF JOWAR (*Sorghum vulgare*) CAUSED BY SPHACELIA (CONIDIAL STAGE OF *Claviceps*). Indian Bot. Soc. Jour. 5: 55–61, illus.

(2) Alberts, H. W., and García–Molinari, O.
1943. PASTURES OF PUERTO RICO AND THEIR RELATION TO SOIL CONSERVATION. U. S. Dept. Agr. Misc. Pub. 513, 46 pp., illus.

(3) Arthur, J. C.
1915. UREDINALES OF PORTO RICO BASED ON COLLECTIONS BY F. L. STEVENS. Mycologia 7: 227–255.

(4) ———
1934. MANUAL OF THE RUSTS IN UNITED STATES AND CANADA. 438 pp., illus. Purdue Res. Found., Lafayette, Ind.

(5) Bessey, E. A.
1950. MORPHOLOGY AND TAXONOMY OF THE FUNGI. 791 pp., illus. Philadelphia, Pa.

(6) Boughey, A. S.
1949. THE ECOLOGY OF FUNGI WHICH CAUSE ECONOMIC PLANT DISEASES. Brit. Mycol. Soc. Trans. 32: 179–189, illus.

(7) Brown, H. B.
1916. LIFE HISTORY AND POISONOUS PROPERTIES OF *Claviceps paspali*. Jour. Agr. Res. 7: 401–406, illus.

(8) Burton, G. W., and Lefebvre, C. L.
1942. POTASH DEFINCIENCY SYMPTOMS IN NAPIERGRASS. Amer. Soc. Agron. Jour. 34: 372–375, illus.

(9) [Cook, M. T.]
1934. TIZÓN DE LA YERBA ELEFANTE. Puerto Rico Insular Sta. Rpt. 1932–33: 90–91.

(10) Curtis, M. A.
1848. CONTRIBUTIONS TO THE MYCOLOGY OF NORTH AMERICA. Amer. Jour. Sci. and Arts, Ser. 2, 6: 349–353.

(11) Dickson, J. G.
1947. DISEASES OF FIELD CROPS. 429 pp., illus. New York and London.

(12) Drechsler, C.
1923. SOME GRAMINICOLOUS SPECIES OF HELMINTHOSPORIUM: I. Jour. Agr. Res. 24: 641–740, illus.

(13) Ellis, J. B., and Everhart, B. M.
1887. ADDITIONS TO CERCOSPORA, GLOEOSPORIUM, AND CYLINDROSPORIUM. Jour. Mycol. 3: 13–22.

(14) Fedorintchik, N. S.
1939. DARLUCA FILUM (CAST.) IN THE CONTROL OF RUST. [Leningrad] Inst. Zashch. Rast. (Lenin Acad. Agr. Sci., U. S. S. R., Inst. Plant Protect.) 18: 61–70, illus. (In Russian, Eng. summary, pp. 69–70). (Abs. also in Rev. Appl. Mycol. 18: 580-581).

(15) Fischer, G. W., and Hirschhorn, Elisa.
1945. OBSERVATIONS ON CERTAIN SPECIES OF USTILAGO ON HILARIA, STENOTAPHRUM, AND MUHLENBERGIA. Mycologia 37: 318–325, illus.

(16) Gray, A.
1908. NEW MANUAL OF BOTANY. Ed. 7, rev., 926 pp., illus. New York.

(17) Guiscafré–Arrillaga, J., Vélez, I., Otero, J. I., and González–Más, A.
1946. BOTANY AND HORTICULTURE. Puerto Rico (Mayagüez) Inst. Trop. Agr. Rpt. 1945–46: 28–33, illus.

(18) Jennings, H. S.
1890. SOME PARISITIC FUNGI OF TEXAS. Tex. Agr. Expt. Sta. Bul. 9: 23–29.

(19) Langdon, R. F.
1942. THE GENUS CEREBELLA CESATI—ITS BIOLOGIC STATUS AND USE. Phytopathology 32: 613–617.

(20) Nattrass, R. M.
1939. ANNUAL REPORT OF THE SENIOR PLANT PATHOLOGIST. Kenya Colony Dept. Agr. Ann. Rpt. 1938, 2: 42–47.

(21) Orton, C. R.
1944. GRAMINICOLOUS SPECIES OF PHYLLACHORA IN NORTH AMERICA. Mycologia 36: 18–53.

(22) Parris, G. K.
1942. EYE-SPOT OF NAPIER GRASS IN HAWAII, CAUSED BY HELMINTHOSPORIUM SACCHARI. Phytopathology 32: 46–63, illus.

(23) PARRIS, G. K.
1950. THE HELMINTHOSPORIA THAT ATTACK SUGAR CANE. Phytopathology 40: 90–103, illus.
(24) PARRIS, [G. K.], and RIPPERTON, [J. C.]
1939. ERGOT OF PASPALUM. Hawaii Agr. Expt. Sta. Rpt. 1938: 38–40.
(25) RATERA, E. L.
1945. ALGUNAS GRAMINEAS TOXICAS PARA EL GANADO. Soc. Rural Argentina An. 79: 287–292, illus.
(26) RHIND, D.
1928. INDIA: MYCOLOGICAL NOTES ON BURMA. Int. Rev. Agr. (n. s.) XIX: 744–745.
(27) RITCHEY, G. E., and STOKES, W. E.
1937. FORAGE AND PASTURE GRASS IMPROVEMENT. Fla. Agr. Expt. Sta. Ann. Rpt. 1936–37: 45.
(28) [RODRÍGUEZ, J. P.]
1938. REPORT ON GRASSES. Puerto Rico Insular Expt. Sta. Ann. Rpt. 1936–37: 69–73.
(29) SEAVER, F. J., and CHARDÓN, C. E.
1926. BOTANY OF PORTO RICO AND THE VIRGIN ISLANDS: MYCOLOGY. *In* Scientific Survey of Porto Rico and the Virgin Islands. New York Acad. Sci. 8: 208 pp.
(30) ————, CHARDÓN, C. E., TORO, R. A., and KERN, F. D.
1932. BOTANY OF PORTO RICO AND THE VIRGIN ISLANDS: SUPPLEMENT TO MYCOLOGY. *In* Scientific Survey of Porto Rico and the Virgin Islands. New York Acad. Sci. 8: 209–240.
(31) SPRAGUE, R.
1950. DISEASES OF CEREALS AND GRASSES IN NORTH AMERICA. 538 pp., illus. New York.
(32) STEVENS, F. L.
1917. PORTO RICAN FUNGI, OLD AND NEW. Ill. State Acad. Sci. Trans. 10: 162–218, illus.
(33) ————, and HALL, J. G.
1910. THREE INTERESTING SPECIES OF CLAVICEPS. Bot. Gaz. 50: 460–463, illus.
(34) STEVENSON, J. A.
1918. A CHECK LIST OF PORTO RICAN FUNGI AND A HOST INDEX. Porto Rico Dept. Agr. Jour. 2: 125–264.
(35) STEVENSON, J. A.
1946. FUNGI NOVI DENOMINATI.—II. Mycologia 38: 524–533.
(36) STEYN, D. G.
1940. POISONING OF STOCK BY FUNGUS-INFECTED PASPALUM GRASSES. Farming in So. Africa 15: 340, 344.
(37) SYDOW, H. and P.
1913. NOVAE FUNGORUM SPECIES. Ann. Mycol. 11: 254–271, illus.
(38) TAKAHASHI, M., RIPPERTON, J. C., and PARRIS, G. K.
1943. SOILAGE CROPS—NAPIER GRASS. Hawaii Agr. Expt. Sta. Rpt. 1941–42: 74–75.
(39) THEIS, T.
1952. AN UNDESCRIBED SPECIES OF ERGOT ON PANICUM MAXIMUM JACQ. VAR. COMMON GUINEA. Mycologia 44: 789–794, illus.
(40) TORO, R. A.
1931. THE CERCOSPORAE OF PUERTO RICO. Porto Rico Dept. Agr. Jour. 15: 5–17.
(41) WARMKE, H. E.
1951. CYTOTAXONOMIC INVESTIGATIONS OF SOME VARIETIES OF PANICUM MAXIMUM AND P. PURPURASCENS IN PUERTO RICO. Agron. Jour. 43: 143–149, illus.
(42) WHETZEL, H. H., and KERN, F. D.
1926. THE SMUTS OF PORTO RICO AND THE VIRGIN ISLANDS. Mycologia 18: 114–124, illus.
(43) WILSIE, C. P., and TAKAHASHI, M.
1934. NAPIER GRASS (PENNISETUM PURPUREUM) A PASTURE AND GREEN FODDER CROP FOR HAWAII. Hawaii Agr. Expt. Sta. Bul. No. 72, 17 pp., illus.
(44) YOUNG, E.
1915. STUDIES IN PORTO RICAN PARASITIC FUNGI.—I. Mycologia 7: 143–150.

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